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TITLE: Strategies to Mitigate Obsolescence in Defense Systems Using Commercial Components [Strategies visant a attenuer l'obsolescence des systemes par l'emploi de composants du commerce]

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Commercial Off-the-Shelf Software and Simulation Tools

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Summary:

In this paper the author will present the arguments supporting the case for using Commercial Off-the-Shelf Software and Simulation Tools (COSST) in major defense systems, whether for actual combat, or for embedded training purposes. Whether the objective is a service life extension, new development, or an upgrade to certain system level functions and operations, COSST have come to represent the solution when budgets and time scales are tight and engineering staff are becoming harder to come by. The author will describe how his company's tools have been layered over the engineering, simulation, test and analysis processes at major defense firms to improve reuse, assist in knowledge capture, and to produce results in major weapons systems programs.

Introduction:

Virtual Prototypes, Inc (VPI) has over 15 years experience as the market leader, working with 350 corporations, focused on the successful deployment of Commercial Off-the-Shelf Software and Simulation Tools (COSST) in the Aerospace and Defense and Automotive industries. Whether the objective is Simulation Based Acquisition, Lean Manufacturing, Collaborative Engineering, Virtual Product Development, or Synthetic Environment Based Acquisition, COSST have come to represent the solution when budgets and time scales are tight and engineering staff are becoming harder to come by. I will present today some of the economic arguments behind the move to COSST by major Aerospace and Defense companies, and how the VPI Enterprise Software Framework (ESF) can be applied to the engineering process.

In the past, VPI customers successfully used one or more of our tools on numerous programs. Until recently, this has been the norm. With human-machine interfaces (avionics and vectronics in Aerospace & Defense (A&D), vectronics alone in Automotive) becoming an increasingly virtual product; i.e., software with performance limited only by the computer hardware environment, it is becoming important to capture the knowledge of the engineering staff involved in its creation. Establishing an integrated, common set of design and test tools with VAPS, FLSIM, STAGE, SEQUOIA and third party products from companies such as Motorola and GreyStone Digital Technologies, starts the critical process of knowledge capture and conservation. This process is contained within the system development, integration and test, flight test (A&D), and training system development (A&D) functions.

It has become increasingly clear throughout the last decade that the visualization and simulation technologies embedded into the VPI virtual prototyping platforms are in direct alignment with the desired goals expressed within strategic business initiatives of Aerospace and Defense and Automotive customers:

- Cost reduction
- Schedule compression (Time to Market)
- Risk mitigation (Focus on Target Market Needs)
- Knowledge capture and information re-use

Economic Reality:

One may ask why the VPI ESF is being implemented in these companies? From the VPI perspective and its experience-base, the VPI ESF has been successful because it meets the strategic business initiatives outlined above. The concept has been proven out over time. The risk of implementation has been significantly reduced/eliminated as a result of VPI successes at many customer sites. This has been accomplished in many complex VPI customer environments such as:

- Lockheed (F-22, C-130, MH-60, F-16)
- Elbit, Litton (SH2G)
- BAE/DASA/Alenia (EFA)
- BAE/Boeing (Wedge Tail)
- Boeing Bold Stroke (Avionics Upgrade Programs)

Interestingly, the motivations to implement the more streamlined and modern VPI ESF process were typically driven by unrealistic, if not suicidal, timeframes due to the inability to hire personnel coupled with the untimely loss of key subject matter experts. We have repeatedly seen highly specialized avionics engineers (e.g. a 17-year veteran) decide to start a new career at a 'dot.com' company and the "avionics expertise" walked right out the door.

Paper presented at the RTO SCI Symposium on "Strategies to Mitigate Obsolescence in Defense Systems Using Commercial Components", held in Budapest, Hungary, 23-25 October 2000, and published in RTO MP-072.

We know these vicious stories because this is a recurring theme in the entire defense related industry, and it is beginning to spill over into other sectors such as Automotive. We have witnessed them at Raytheon, BAE, Matra/BAE missiles, Alenia and, as of lately, in MATRA/DaimlerChrysler Aerospace (EADS). We have personally watched this breath-taking exodus injure the quality, and knowledge base of the work force. Expertise continues to “walk right out the door”.

VPI has built its business model precisely around this market condition:

We want to help customers retain expertise through the employment of the VPI ESF and achieve their demanding schedules. We deliver a solution that allows customers to maintain a reduced staff and an appropriate level of accumulated expertise, in spite of the exodus. We are interested in helping our customers get 40%, 50%, 60% better (e.g.16 months reduced to 9 months, doing the work with 300 engineers instead of 500, eliminate re-work in software code development, etc., etc.). We are interested in shocking the system to a new level of productivity and information re-use.

Getting the best of both the worlds:

It is fully recognized that that our customers have developed much quality custom software internally. This includes efforts from many years resulting in an array of models for flight simulation, radar, navigation, etc.

As we have seen however, the increasing burden of maintaining both the topic-specific software and the framework that houses the basic components has become uncomfortably expensive. Most of the framework for legacy software has not been migrated to modern programming languages or new computational platforms. As key staff member attrition takes hold, the flexibility of using this legacy infrastructure becomes more difficult daily. The situation is complicated by the use of government created software tools, which may also be out-of-date or generally are awkward to manage/modify. These conditions have driven an unstoppable movement to COSST-based tools.

Specifically, how does a customer reap the benefits of their current proprietary efforts and the benefits of COSST?

Rather than continuing the current engineering practice of having many integrators involved in various parts of the system development process, as shown in Figure1, Virtual Prototypes, Inc. assists customers in the creation of an Integrated Desktop Prototyping, Design, Simulation and Testing Environment (IDPDSTE) as shown in Figure 2. Now, several large customers are moving in the direction of using the entire set of VPI tools, in a flexible framework, to respond to enterprise goals such as LEAN Engineering and Optimizing the Value Stream. By supporting this move, VPI is presenting a solution that benefits many programs throughout the life cycle of each program and its derivatives. COSST are moving out of the realm of "valuable point-solutions” to “strategic enterprise-solutions" within the business process.

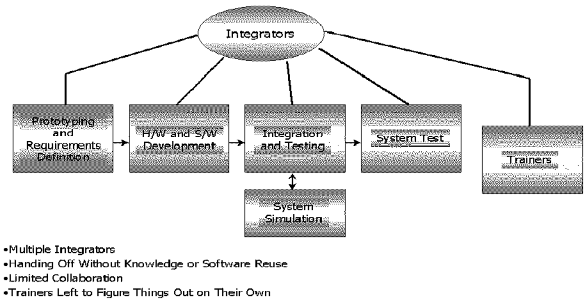

Figure 1 - Existing System Development Process

The proposed solution offered by VPI allows Customers to get the best of both worlds. First, we build a framework that integrates the existing subject matter specific software into a common and modern architecture. This architecture is the VPI ESF. It is COSST-based and is flexible to allow for changes through time. It is fresh and modern, and allows for years of typical framework creation to be accomplished in a few months. The outcome retains the valuable customer legacy development efforts, yet inserts these pieces into a modern and contemporary low-maintenance framework.

The result is that customers will be able to re-direct their efforts to subject specific content and diminish involvement in software maintenance and enhancement. The engineers will do the engineering and VPI software will maintain the framework.

It is interesting to note that almost all VPI customers have significant investments in legacy tools. It has been shown that, in spite of the investment in that area, there are significant gains that can be incrementally obtained by further automating the engineering process. This is accomplished by implementing the VPI COSST Framework and leveraging existing legacy models (e.g. flight simulation, radar, etc.).

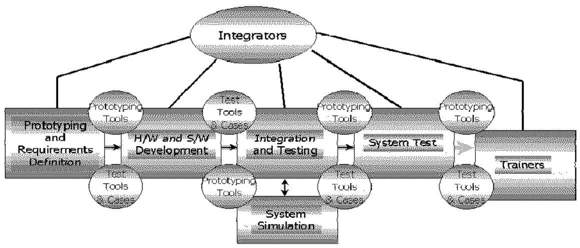

Figure 2 - Integration of Common Tools across the Engineering Process

Re-using Knowledge and Information:

Reuse of Knowledge and Information is the key to success. As a result of implementing a framework that allows for information re-use, many redundant efforts are eliminated and a task is done once and is then available for access in future months and years by other groups. It should be noted that this continuity and information re-use is possible even though there may be significant turbulence in staffing.

Additionally, the VPI Framework allows for all the knowledge and information to be passed along the Value Stream in a contiguous and re-useable manner.

The thought of a new framework technology that allows for dramatic gains in the triangular management of time, cost and risk will not be received well by all. People at many levels will be "protecting their local empire" and may resist this proposal. This is not a shock to us; we see it daily.

Other groups of leaders and "change agents", who are interested in achieving 20-60% improvements and "shocking" the system will endorse it. We have done this elsewhere in equivalently complex environments. As much as those who are protecting their empires will argue this point, it is fact, and is not a debatable topic. However, during these transitional times when empires are being protected, the need for high-level management support is crucial.

Process:

Virtual Prototypes will integrate FLSIM, STAGE, VAPS and our other software products into an enterprise framework. The purpose of the integration will be to create a seamless integration of tools permitting the early identification of design problems, reallocation of requirements, and sharing of information across specific knowledge domains during avionics development. This integration will focus on creation of a desktop environment focusing on integration of these design and test tools, with existing customer proprietary tools where necessary, across the existing avionics life cycle (software development, testing, training) engineering process. The aim is to initially shadow the existing customer processes and overlay the tools onto the process to aid in the knowledge capture process as shown in Figure 2. Part of the emphasis, as shown in Figure 2, is to more closely integrate the Training segment with the rest of the processes, shown by gray arrow across all five major sub-integrator blocks.

Code Generation Automation and Common Test Environment:

The advantages of undertaking this effort are Code Generation Automation (CGA) and a Common Test Environment (CTE) from Desktop to Simulator to Aircraft. The advantages of code generation automation are shown in Figure 3 and include:

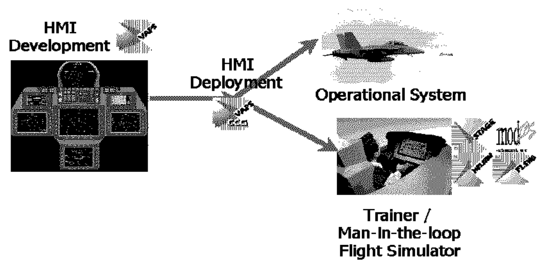

Figure 3 - Code Generation Automation Advantages

- Retention of the programming knowledge of the program as mentioned above
- The ability to have the staff focus on optimization of the value added tasks such as mission critical skills.

Code Generation Automation:

Generation of code from the tools during the prototyping stage of development provides the means for elimination of rewrite over the engineering process by the furtherance of reuse. Reuse of generated code ensures the viability of code before integration and testing and provides a means of up-front validation. The visual nature of prototyping with tools supports the "Art to Part" process within the Virtual Manufacturing paradigm. The tools also eliminate the present engineering practices of reconstructing the code at each intermediate process of the project life cycle. The inclusion of the Design Documentation tool with VAPS increases performance by permitting the automated generation of design documents for use throughout the project life cycle by an integrated product team. The prototyping tools also support the embedding of safety of flight critical rules prior to the code being generated.

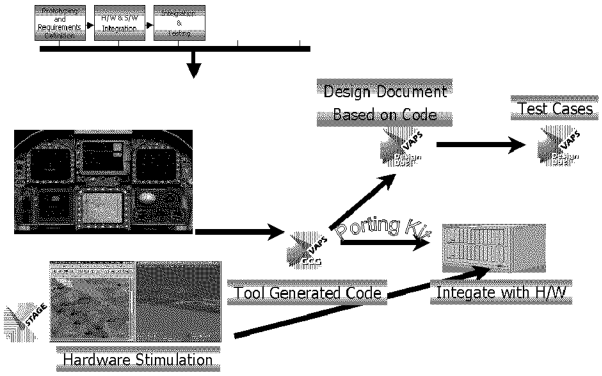

Figure 4 - Code Reuse

Common Testing Environment:

Additionally, this Common Testing Environment brings a level of consistency that has been missing in avionics development in the past. The CTE will provide for reuse of test cases, a sort of data fusion, as well as permit the optimization of resource utilization during testing by reducing or eliminating bottlenecks in scheduling test resources. The CTE supports the performance of full functional testing within a synthetic environment. The CTE envisioned by the integration of VAPS/FLSIM/STAGE creates a shared test environment that can be reconfigured for each process (Figure 5). The CTE creates a repository for a common database of test cases, thus increasing consistency of results across the process. Fully, a 20% to 30% reduction in support personnel is possible.

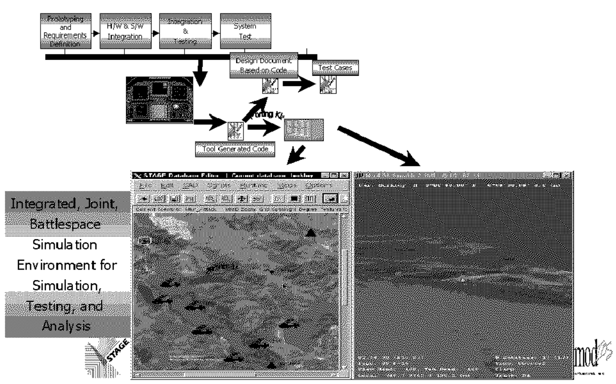

Figure 5 - Fully Integrated CTE with Synthetic Test Environment

Linkage to Support and Training Systems:

If one goes back to Figure 1, it is shown plainly that the Training/Support Systems portion of the overall Systems Development process has no clear linkage as one traverses prototyping and requirements definition, hardware and software integration, integration and testing (including flight test), and system testing. Training/Support Systems is "left to fend for itself" for design information, performance data, and code. Often, the training systems designers write their own code due to a lack of information flow and/or to maintain a delivery schedule consistent with weapon system delivery. With the type of ESF being shown, this will no longer be the case. The Training/Support Systems group can leverage directly from the knowledge capture taking place across the system development process through the use of the same common tool set. The avionics software will be identical to that produced during prototyping and requirements definition and then reused throughout the remainder of the system development process via automated code generation. By sharing like synthetic environments, Training/Support systems will be participating in the knowledge capture process and will reap the benefits of code and database reuse. This can provide the same 20% to 30% productivity increases as expected in the overall system development process. Figure 6 depicts the expected end-to-end results.

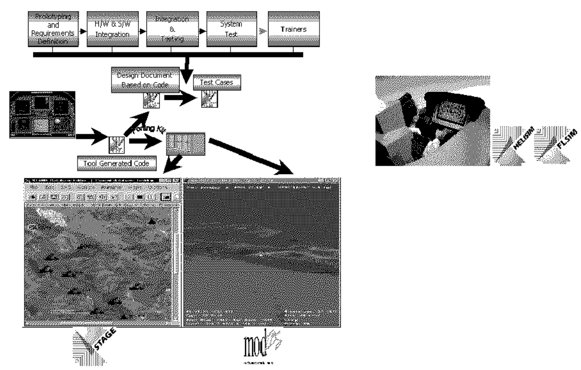

Figure 6 - End-to-End Results of Utilizing Code Generation Automation and a Common Testing Environment

How the VPI ESF Mitigates Obsolescence in Defence Systems:

First, the VPI ESF is composed entirely of Commercial Components, or what you would call Commercial Off-the-Shelf (COTS) software. Second, Human System Interfaces are one of the largest drivers in any weapons system or command and control system development. Third, these Human System Interfaces frequently undergo the largest number of modifications or upgrades in the life cycle of a system.

By using tools, which generate code in a manner that can be qualified for flight, industry and government will save between hundreds of thousands and millions of dollars upgrading avionics systems in the future. The reason is simply the fact that tools will eliminate many of the tedious hand coding steps currently performed by engineering staffs today. Other benefits of tool use are the ease of making changes and reducing risk. Technical risk is reduced through machine generation of the code

(machines do not get creative). Schedule risk is reduced by the fact that code generation is quicker and less expensive than hand coding, thus a shorter schedule can be supported.

On July 24th of this year, Frost & Sullivan (http://www.frost.com) published a report indicating significant upgrade programs in the military avionics markets in the United States and Europe would lead the industry through the next few years. Instead of procuring new equipment, air forces in these countries will maintain older fleets of aircraft while investing much of their budget on avionics and electronic warfare upgrades. Virtual Prototypes believes its tool based ESF solution can keep these upgrades from costing more than initial estimates. ESF can also reduce the probability of schedule delays and diminished functionality upon delivery.

Furthermore, the introduction of new fighter planes and the advent of Global Air Navigation System/Global Air Traffic Management will drive avionics upgrades in other parts of the world. The military air transport avionics market is also driven by the need to upgrade and develop better airlift capabilities around the globe. Recent conflicts have demonstrated the vital role of airlift in military operations. Europe and United States are at the forefront of development and upgrade programs for their fleets. Virtual Prototype's believes that without a robust solution to the brainpower drain, these countries will be hard pressed to complete these upgrades in a timely manner. Again, the ESF solution can help.

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